

**WASHINGTON STATE DEPARTMENT OF
TRANSPORTATION (WSDOT)
COST ESTIMATE VALIDATION PROCESS (CEVP)
URBAN CORRIDORS PROJECTS
“BEST CURRENT COST RANGE”**

JUNE, 2002

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1. EXECUTIVE SUMMARY

INTRODUCTION

This document gives background about Washington State Department of Transportation's (WSDOT) Cost Estimate Validation Process (CEVP). CEVP was developed by WSDOT Managers David Dye and Cliff Mansfield, with Consultants John Reilly and Michael McBride, in January 2002, in response to an urgent need to better identify, quantify, understand and manage the costs of the large, complex highway projects proposed for construction by WSDOT.

The process is still in development, but it has already produced dramatic, tangible results for several large WSDOT projects which are being considered for funding in the up-coming State and Regional packages.

The projects evaluated, which are included in the State and Regional packages, are:

- | | |
|---|---|
| 1. SR 99 Alaskan Way Viaduct and Seawall Project, Seattle | 5. I-5/SR 16 HOV Lanes, Pierce County |
| 2. SR 520 Trans-Lake Washington Project, King County | 6. SR 167 Extension, Pierce County |
| 3. I-405 Corridor Project, King County | 7. I-90 Snoqualmie Pass, Kittitas County |
| 4. SR 509 Extension, South King County | 8. SR 395 North Spokane Corridor, Spokane |
| | 9. I-5 Everett HOV, Everett |

PUBLIC INFORMATION RELEASE

The initial CEVP summary results for projects No. 1-8 were released in briefings to state and county officials and the press, June 3rd, 2002. Reception has generally been very positive and has served to focus discussion on the choices to be made. WSDOT has been commended for its efforts to inform the public about the probable costs of these projects and to communicate openly.

Key summaries of these projects and the CEVP results are included in this informational package under Tab 2 and are available on the WSDOT Website at <http://www.wsdot.wa.gov/projects/cevp/default.htm>. Further details will be posted on the web as they are developed.

THE COST ESTIMATE VALIDATION PROCESS (CEVP)

The CEVP process basically includes:

1. Review and validation of existing WSDOT project cost estimates by the cost experts of the CEVP Validation Team and representatives of the Project Team ("Cost Team").
2. Incorporation of risk events which can affect the cost of the project by the risk experts of the CEVP Validation Team and representatives of the Project Team ("Risk Team").

The CEVP process is intended to develop significant recommendations regarding cost, potential risk events and risk mitigation strategies to the Project Team and WSDOT Executives. The results of the CEVP workshops are, generally:

- Additional definition, clarification and understanding of the current project estimate.
- Assessment, if possible validation, of costs included in the current project estimate.
- Recommendations for reduction from, or addition of costs to, the estimate.
- Identification of specific risk events, which could influence the ultimate project cost or schedule.
- The identified risk events form a basis for development of a risk mitigation plan.
- Information about funding scenarios, alternatives, cashflow and project phasing.

2. WSDOT WEB – CEVP OVERVIEW

The following text is a summary of the CEVP process which was posted to the Web on June 3rd, 2002. This was concurrent with the release, to State and County officials and the press, of the initial CEVP summary results:

Since February, WSDOT has intensified efforts on cost estimation for the state's largest transportation improvement projects, or "mega projects," included in the Referendum 51 project list. Some of these mega projects could be important parts of the Puget Sound area regional transportation package authorized under legislation passed last March.

This project cost information can be used as officials from King, Snohomish, and Pierce Counties develop 10-year financing and expenditure plans for a program to address some of the Puget Sound region's most significant transportation problems.

WSDOT and state and regional decision makers are aware of public concern and skepticism about the costs of large public projects and how costs just seem to grow and grow. WSDOT wants the public and decision makers to have the best possible information about the likely cost ranges of major transportation projects. The word "range" is important. We cannot wholly predict the future, but we can, with this cost estimating tool, better forecast the range of costs and time a project will require. And then we can more realistically plan for the best – and also the worst – possibilities.

WSDOT has developed the Cost Estimate Validation Process (CEVP) based on the latest cost estimating experience around the country and elsewhere in the world.

CEVP is an intense workshop process, somewhat resembling value engineering. Each project is examined by a team of top engineers from private firms, public agencies from around the country, risk managers, and WSDOT engineers. Many of the participants have had extensive first-hand experience in large project programming and delivery.

CEVP recognizes that every project cost estimate will be a mix of the very likely, the probable, and the maybe. Meeting the estimate of the number of yards and the cost of concrete to be poured for a roadway is pretty likely. It's probable that if the project is built five years from now, inflation will add 20-25% to "today's" project costs – but it would be a different ball game, and probably 15% higher cost, three years after that. And a big maybe – looking into the crystal ball – is whether contaminated soil would be encountered during construction requiring expensive cleanup costs.

The CEVP workshop uses systematic project review and risk assessment methods, including statistics and probability theory, to evaluate the quality of the information at hand and to identify and describe cost and schedule risks. Importantly, the process examines, from the very beginning, how risks can be lowered and cost vulnerabilities managed or reduced. In other words, a dividend of CEVP is to promote the activities that will improve end-of-project cost and schedule results.

CEVP will help communicate to the public the risks identified and their potential cost impacts – so that the public can understand the limits and assumptions of an estimate and better understand what people will actually see as the project proceeds.

What A CEVP Summary Shows

- Project description and benefits
- Schedule assumptions to adjust estimates to "mid-point of construction" dates for inflation
- Project cost probability ranges at current state of design
- Major risk factors and unknowns to which cost estimates are subject.

Summaries have been provided for "full project implementation" and also for scenarios where parts of projects could be undertaken within an overall regional plan. These scenarios have been selected from many possibilities that decision makers could choose.

CEVP provide backup detail for the conclusions stated in the summaries.

We believe CEVP will improve everyone's ability to work together on a regional proposal leading to reasonable expectations about what can be delivered from new taxes. It will also improve accountability for the public agencies delivering the projects.

The CEVP Summaries:

CEVP summaries for each mega-project are attached with options for potential project phasing and staging. Each project's CEVP summary reflects the unique features of a separate project. But all of the summaries share the following points:

- Project cost estimates are stated in dollar ranges, not as single numbers. This reflects the limits of estimating precision at the planning stage when crucial decisions are yet to be made and the specific risks cannot be exactly determined.
- Risk considerations specific to each project are identified and described so that specific risk issues can be foreseen, discussed, and evaluated by the public as the project moves forward.
- Likelihood of project construction schedules have been taken into account and schedule-based adjustments made to the estimates to reflect the smaller purchasing power of dollars to be spent on construction several years in the future.

CEVP is still being developed. The CEVP summaries are not a warranty that the estimates are perfect, for it is true that you only know the final costs of a project when the project is finally completed. CEVP cannot change the fact that it is very early in the project development process for many of these major projects. There are still many unknowns. But risk areas that could drive up project costs can be communicated fairly to the public. In addition, the early identification of a risk area creates management opportunities to minimize the potential of project costs associated with some of those risk areas.

3. SUMMARY, CEVP PROCESS

This section outlines development and implementation of the WSDOT Cost Estimate Validation Process (CEVP) during the period of February through June 2002, including an overview of CEVP as it has been designed and implemented during this period.

At the time of this writing, July 1, 2002, several project CEVP reviews are still in an active state with draft reports still being finalized or under review for comment by Project Teams. Summary 1-page findings of all projects reviewed to date are included in this informational package under Tab 2 and are available on the WSDOT website – go to <http://www.wsdot.wa.gov/projects/cevp/default.htm> and click on the specific project. Copies are also included in this package. Further details will be posted on the web as they are developed.

CEVP Workshops

The purpose of a CEVP workshop is to perform a peer-level review, “due diligence” analysis on the scope, schedule and cost estimate for the major projects of the Urban Corridors Program. Specific objectives are to evaluate the quality and completeness, including anticipated risk and variability, of the estimated cost and schedule.

The CEVP report is generated from a multiple-day concentrated workshop led by senior WSDOT personnel with the aid of specialized consultants and involving the WSDOT Project Team.

Prior to the workshop, each of the Project Teams prepared plans, exhibits and project documents to describe the scope, character and timeframe of the project. The Teams bring their existing cost estimates, including the “base” project costs plus allowances and contingencies. Additionally, the Teams are requested to address “risk events,” such as the potential for additional requirements to meet environmental regulations, geotechnical uncertainties in constructing high retaining walls, or the discovery of unexpected utilities. This pre-workshop information is reflected in the Appendices of each final CEVP report.

In addition to working to validate project costs, CEVP also serves to document the viability of assumptions made regarding the project’s configuration, scope, schedule, and through the risk analysis, the potential impact of risk events. These risks events include three types:

1. Those within WSDOT control such as the project delivery method
2. Those controlled by entities other than WSDOT such as legal challenges to environmental documentation or mitigation
3. Those which are caused by “uncontrollable events” such as natural disasters

For purposes of the CEVP report, two fundamental definitions are required¹:

1. Base cost – The most basic cost for a unit or element of the project. The base cost represents the cost which can most reasonably be expected if no significant problems occur, with typically small uncertainty or variance. The base cost is not a lower bound or minimum cost estimate because some risk elements are always present.
2. Risk events – Potential adverse events that affect the project resulting in impacts to cost, schedule, safety, performance or other characteristics, but do not include the minor variance inherent in base costs.

¹ A glossary of terms is available and is include with the project reports

CEVP Process

The CEVP process deals with base costs and risk events separately. The CEVP workshop is divided into two phases:

1. Cost Assessment or Validation – A detailed examination of base costs (including allowances) to assess the validity, reasonableness, consistency and accuracy of the Project Team Estimate
2. Risk Analysis – A detailed examination of contingency and risk to develop projected costs and schedules related to, or caused by, potential risk events. A consideration of variability is included in this work element.

The CEVP process includes:

3. Review and assessment or validation of existing WSDOT project cost estimates by the cost experts of the CEVP Validation Team and representatives of the Project Team (“Cost Team”).
4. Incorporation of risk events which can affect the cost of the project by the risk experts of the CEVP Validation Team and representatives of the Project Team (“Risk Team”).

Cost Analysis

In general the project estimates for the WSDOT Mega Projects consist of the base costs plus various design allowances and contingencies to allow for known but currently undefined costs, unknown requirements or expected problems in construction. The Project Estimates vary in level of detail depending on the level of engineering completed on each project.

The Cost Team performs a “due diligence” review of the project estimate, focused on quantities, unit prices and project indirect costs to assess the current project estimate. Part of this assessment is the removal of cost elements such as “allowances, provisions, contingencies” in order to determine the base cost. The Cost Team provides an opinion on the soundness and completeness of the estimate presented.

Risk Analysis

In the CEVP work to date there has been a wide variation in the way that Project Teams have dealt with allowances and contingencies. An important part of CEVP has been to deal with this variable approach in a way that provides consistent and comparable results.

The existing Project Team Estimate provides a “point estimate,” or single project cost, usually including allowances and/or contingencies but without explicitly including significant risk events that could occur. However, we know that the “ultimate cost” of a project is subject to variables and potential risk events, which can significantly influence the range of “probable projected cost”. Any one cost number represents only one possible result of these multiple variables and assumptions which are not all directly controllable or absolutely quantifiable.

The cost estimating process used must therefore consider probabilities and risk events in estimating cost, using a recognized, logical and tested process, so that reasonable conclusions can be drawn as to the most probable range of cost for the alternatives and risk events considered. In the CEVP process the range of the cost estimate at any stage in a design will be composed of a base cost, that will evolve as the design matures, and a risk component that will also evolve. It is typical for the risk component to decrease as the design matures but there will always be some residual risk component in the total cost estimate until the project is completed.

The listing of risk elements reflects issues that the Project Team has identified in their design work and had included in the contingency. As the design has evolved, many of these risk items are being addressed by the Project Team and we expect that there will be continuing changes in design to realize the potential for risk management. Major assumptions concerning risk items are summarized subsequent to the risk-item discussion.

Risk Assessment

The risk assessment process is conducted simultaneously with the base cost evaluation. The following activities constituted the risk assessment:

1. A project flow chart is developed combining the sequence of major activities to be performed in the Project. The funding decision points, as described by the Project Team, are explicitly represented in the flow chart. The flow chart combines specific project elements in clusters of activities to represent the expected project flow and sequence of work
2. The “base” costs and duration for each activity on the flow chart are determined based on values confirmed or defined by the cost analysis verification team.
3. Missing items and modifications to the original Project Team plan are identified by the joint work of the cost team during the cost analysis verification activity. Indications of risk are also identified by that team and forwarded to the risk team for an analysis. The risk items and base cost items are coordinated during the evaluation process to assure that no gaps or overlaps exist.
4. The Risk Team identifies and evaluates the major risk elements and issues of concern for all of the project activities on the flow chart. For each item the team evaluated the likelihood of occurrence, possible outcomes, the potential cost impacts and the possible schedule implications. These risk issues, impacts and possible mitigation actions are described below.
5. A probabilistic model is then developed and used to analyze the risk of potential cost and schedule changes for each project. Both escalated and non-escalated (current dollars) costs are evaluated and reported. A summary of the output of this model is provided following the discussion of major risks and issues of concern.

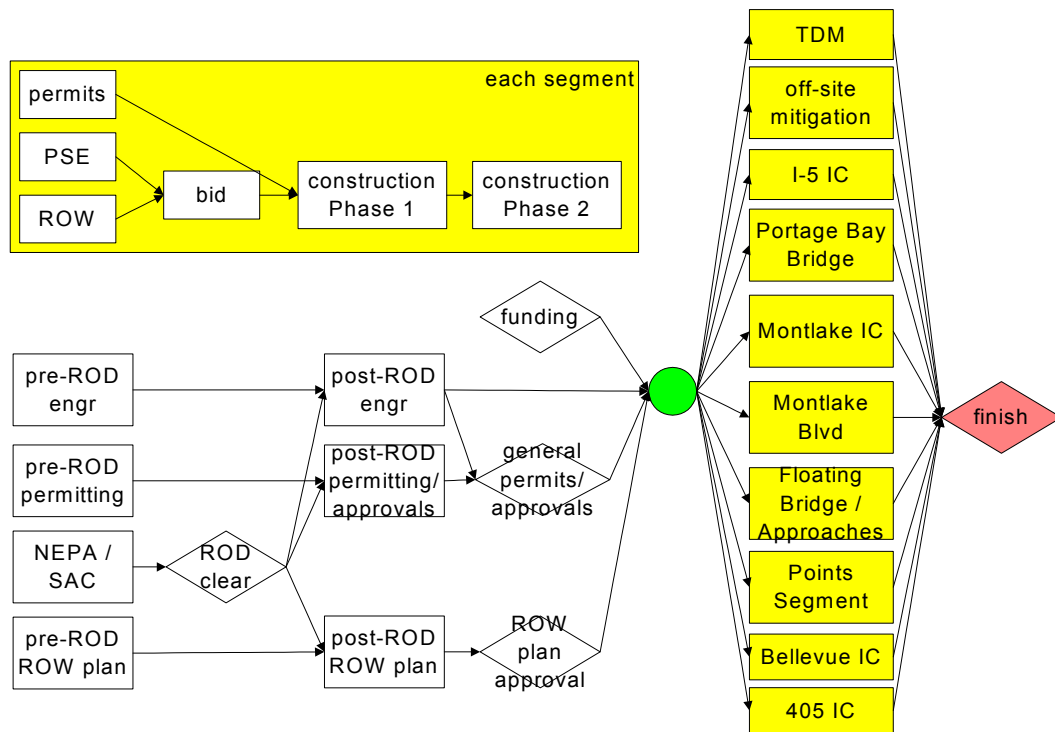


Figure 1 - Example of a Project Flow Chart (Example is SR520, Translake):

Risk Elements / Issues of Concern

The Risk Team identifies potential risk elements that could be defined as major issues, using a screening criterion to separate major issues having a cost impact of (say) \$1 million or more, or a schedule delay of 1 month or more. Minor risk elements, those below the screening criteria, are carried as a single miscellaneous risk element with cost and duration expressed.

The Risk Team assessed these items in terms of their possible impact and the probability of occurrence. Project Team members were actively involved in identifying these impacts and probabilities, including members of both Risk and Cost Teams. Generally, the probability of occurrence is estimated on a qualitative scale that is then translated to a percentage probability using guidelines such as:

Probability Percentage	Subjective Criteria
50-100%	Very likely
25-50%	Likely
10-25%	Possible
1-10%	Unlikely
>1%	Very unlikely

Table 1 – Probability limits vs. Subjective Criteria

Identification of Potential Risk and Opportunity Events

Risk events are those with negative cost or schedule impact. Opportunity events are those with positive cost or schedule result.

For each project, risk and opportunity events are identified based on the knowledge and skill of the Project and CEVP team members. Issues, impacts, probability and potential mitigation measures are described for each project. In addition, the profile of risk or opportunity events are summarized for full-funding and partial-funding project scenarios, if applicable. The output is a listing of all identified issues of concern and potential risk events. For each event the following is defined:

Issue: A definition of the issue or risk or opportunity event, including causal events or triggers. or environment, opportunities the consequences in time or cost impact, the probability of occurrence, the shape of the event (probability distribution(s) or levels of impact related to the distribution).

Impacts: The cost(s) or schedule penalty(ies) of the event.

Opportunity: The cost(s) or schedule benefit(s) of the event.

Probability: The chance of the event occurring.

Mitigation Measures: Possible ways to eliminate or reduce risk events and possible ways to enhance opportunity events.

All of the above may include multiple scenarios for each event. An example of the results is given following (*example is from SR520, Translake Floating Bridge, numbers are not representative*)

Potential Risk / Opportunity	Cost Change	Duration Change (months)	Probability
a) Existing floating Bridge failure, or b) Portage Bay Bridge failure before replacement	a) -\$170m b) -\$35m	a) +24 months b) +24 months	a) 5% b) 3%
Simplify the I-405/SR520 interchange to reduce Right-of-Way taking costs	+\$150m	-8 months	40%

Table 2 – Examples of Potential Risk & Opportunity Events

Results

The risk /cost model is run using a “Monte Carlo” simulation. This runs multiple combinations, usually 1000 iterations, of the defined variable risk and opportunity events, which are combined with the base costs and schedules, to produce probable ranges of cost and schedules.

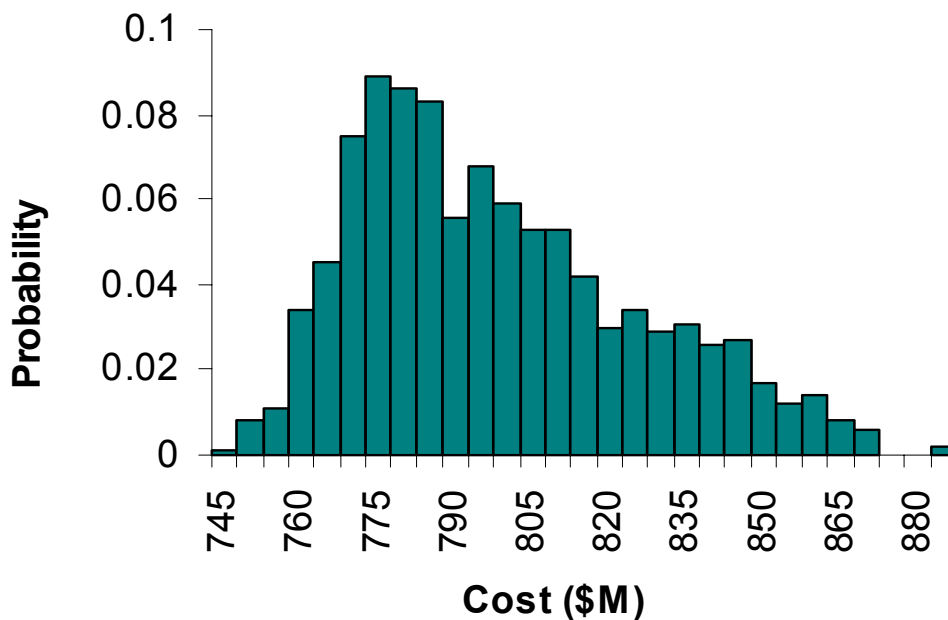
Current year costs and escalated (time of expenditure) costs are computed. Time of expenditure costs are calculated by escalating the specific activity cost elements to the probable time of construction (which varies depending on the scenario) using defined escalation percentages for that element.

Results are presented as Cost and Schedule Ranges for the fully-funded Project - and partial funding scenarios if applicable. The ranges have specific probability characteristics and are reported as percentage values.

For example, a 10% probable cost level represents that there is a 10% chance that the cost will be less than this number and that there is a 90% chance that the cost will be greater than this number.

Similarly, a 90% probable cost level represents that there is a 90% chance that the cost will be less than this number and a 10% chance that the cost will be greater than this number.

The following graphs show probable year of expenditure costs for one funding scenario (*the example shown is for the I-90 the Snoqualmie Pass East Project*).



There is a 10% chance the cost is less than \$ 760 Million
There is a 50% chance the cost is less than \$ 790 Million
There is a 90% chance the cost is less than \$ 840 Million

Figure 2 – Example, Range of Probable Costs (I-90 Project)

Commentary on the Range of Probable Costs

Each project summary has a commentary on the results – including completion of design, range and profile of the probable costs and schedule. For example, for the above project (I-90):

“...the long tail of the probability curve is due to the limited escalation in construction cost over time since the tunnel construction, a large risk item, is an early activity”.

“The increase in the Project Team Estimate is principally due to more accurately portraying the cost and delay from risks to the project (specifically more stringent seismic criteria, the seasonal nature of the work, and potential environmental approval delays to name a few).

“The project duration is based on a design-bid-build delivery method. The project duration would be considerably shorter with a design-build delivery method. Subsequently, this would reduce escalation cost. The project would realize additional costs for a stipend to unsuccessful bidders and consultant costs to supplement WSDOT staff for the fast-track program management environment.”

Ranking of identified Risk Events

The model reports the contribution of identified risk events (and opportunities) to the probable cost and schedule ranges. These are summarized in the reports. An example (*SR520 Translake*) follows:

Rank	Contribution to Risk Cost ¹	Risk Event (#, description)
1	26%	12. Seismic criteria
2	21%	2. Sound Transit Rail N Link Realignment
3	13%	30. Project Delivery Method
4	10%	31. Other (low risk) items
5	10%	22. ROW
6	7%	3. Market Conditions (high bids)
7	3%	14. Constructability of I-405 IC
8	2%	26. Local Access improvements
9	2%	28. TDM
10	1%	16. Construction staging areas

Note 1: contribution is stated in current \$, for the fully-funded case.

Table 3 – Example of Event Ranking / Contribution to Risk Cost

Report review, finalization and disposition

The results of the CEVP Workshop are presented first in an initial PowerPoint presentation at the end of the Workshop. Subsequently, a draft report is given to the Project Team for review, comment and feedback which is given in a post-Workshop meeting, which is scheduled several weeks after the conclusion of the CEVP workshop.

Between the conclusion of the CEVP workshop and the feedback session, several areas are addressed by the project team:

1. The Project Team reviews and substantiates the revised Base Cost Estimate that has been prepared during the CEVP workshop.
2. The Project Team reviews and comments on the Risk Elements identified in the CEVP workshop.
3. The Project Team begins to develop a plan to mitigate the risks identified in the CEVP workshop.
4. The Project Team identifies additional areas of concern to be addressed.

After these steps and post-workshop activities the CEVP report is finalized.

Additional Analyses

The projects may request that further model runs and revisions be made to adjust for changes in project requirements or for partial-funding alternatives.